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The American Biology Teacher

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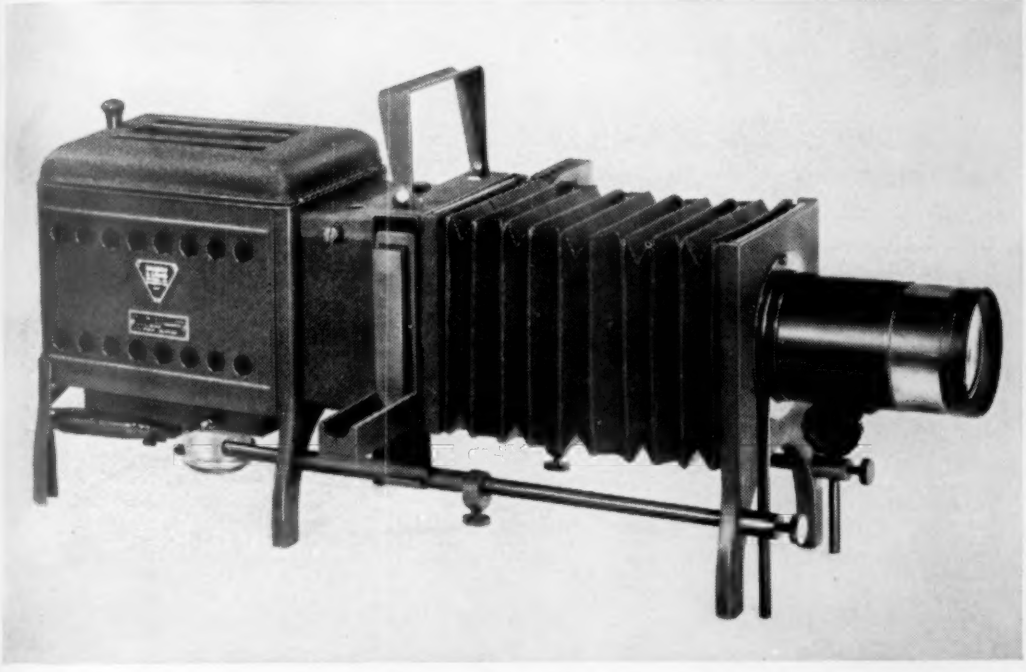

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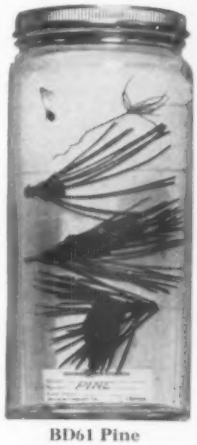

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The American Biology Teacher

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Snail Studies in Elementary Biology

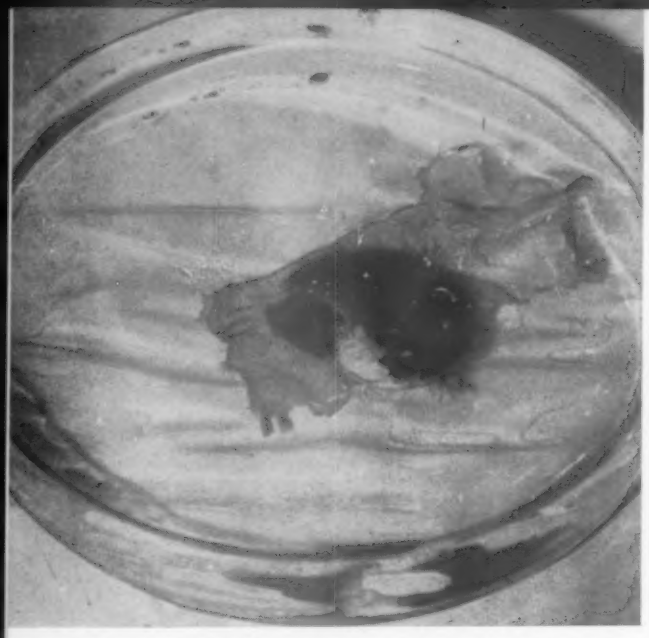
KARLEM RIESS
Tulane University, New Orleans, Louisiana

For many years the snail has been overlooked as a desirable specimen for elementary study. In the usual high school laboratory snails are found in every balanced aquarium. Their function as scavengers is mentioned briefly. Some instructors include the snail in the general classification system. That is just about all that the beginning student learns about them.

A survey of modern laboratory manuals and workbooks substantiates this. There is no mention of the snail as a specimen for student study. The usual reason given for this omission is that the snail is too difficult for the beginner to dissect. To overcome this a series of simplified studies has been devised for use in the high school biology course. These may be adapted to the junior college or college level. The studies were motivated by the general belief that the more familiar a laboratory specimen, the more interest is displayed by the students.

In most localities there is ample material available. All common land and pond snails are suitable for general observation. For dissection purposes the larger varieties are preferable. Most of the commercial biological supply houses are able to furnish a wide assortment. Some of the more familiar varieties for study are the land snail *Helix pomatia* and the fresh-water types *Physa* (pond snail); *Limnea auricularia* (African paper shell); *Limnea peregra* (wandering snail); *Limnea palustris* (marsh snail); *Planorbis corneus* (black or brown ramshorn); *Planorbis corneus rubra* (red ramshorn); *Paludina vivipara* (live-bearing snail); *Ampullaria gigas* (four-horned snail); *Viviparous (intertextus) contectoides* (Potomac green snail) and *Viviparous malleatus* (the black Japanese snail).

Snails of the land type are conveniently studied in a woodland terrarium. Woodland mosses, liverworts and native ferns, growing in humus or dampened leaf mold, serve as an adequate environment. Most of the land varieties enjoy shade and a little moisture. A number of these feed on the decomposing animal matter, or may be given fresh lettuce leaves.



Planorbis corneus, feeding on lettuce. This specimen, recently obtained from an outside pond, carries a growth of algae on the shell. A Petri dish is quite suitable for student observation. Photograph by A. E. Martin, Jr.

Aquatic snails may be kept easily in the balanced aquarium. They feed on algae, on prepared powdered fish food, on food not consumed by the fish, and on decomposing animal matter. For the smaller varieties dried powdered lettuce leaves or rice flour is suitable. Ramshorns like a little raw meat at the point of decomposition. Japanese snails enjoy powdered cuttlebone. *Ampullaria* prefer water plants.

Marine snails thrive in the salt-water aquarium. Marine algae, seaweeds and artificial foods may be used. These snails are more difficult to keep than the fresh-water varieties.

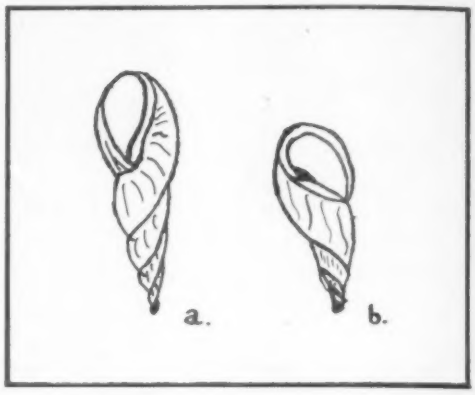
Suggested Studies

1. General Observations

An assortment of both types of snails may be used. This study should include detailed observations on (a) differences in external appearance; (b) method of locomotion; (c) method of feeding; (d) length of life; (e) differences between land and aquatic varieties.

2. Shell Structure

The rotation of the snail shell forms a unique study. The student of artistic nature may sketch many snail shells, and arrange according to type of rotation. The two types are dextral (right-handed) and sinistral (left-handed) coiling. For example, *Limnea* is dextral; *Physa*, sinistral. *Physa* has a short, spiral shell. *Planorbis* has a flat, spiral shell. If marine snails are available, the students may compare the shell formation of these with fresh-water varieties. If desired, the shells themselves may be preserved and arranged for display.



Shell rotation
(a) *Limnea* (dextral).
(b) *Physa* (sinistral).

3. Water Effect

Snails are familiar trouble-shooters in the fresh-water aquarium. They tend to stay close to the edge of the water if it is foul or improperly seasoned. They object to excess oxygen in water.

For the more advanced students, or for a special project, the relationship of the *pH* of the aquarium water to the normal activity of snails is an interesting area for study. Using pond snails or any of the ramshorn varieties the effect of water of *pH* ranging from 4.0 to 12.0 may be investigated. This necessitates a rapid method for determining *pH*, such as commercial *pH* papers, or the spot-plate tests with indicators and color charts. Either of these is accurate enough for elementary work. The slight changes in acidity or alkalinity necessary may be produced with dilute hydrochloric or acetic acid, or with sodium or ammonium hydroxide. The effect on the shell, on locomotion, general health, feeding habits, color, length of life, etc., may be noted. Similar observations on the plants in the aquarium may be made.

This study may be extended, using rain, pond water, river water, artesian water, etc.

4. Reproduction

The snail illustrates two types of reproduction, egg-laying and live-bearing. These may be compared, using live specimens. The reproductive organs may be studied through dissection. A study of the development of the embryo would complete the analysis.

The Japanese snail is live-bearing. The young are born fully developed, quite small, and able to take care of themselves. The sexes are easy to identify. The right horn of the male is slightly longer than that of the female. Females once impregnated seem to remain fertile for the remainder of life.

The *Ampullaria* lay masses of large, beautifully colored eggs on the side of the aquarium, above water. The egg mass is about ¾ by 2 inches. The young fall into the water as the eggs hatch.

The African paper-shelled snail is a very rapid breeder, but short-lived. The young of the Africans and ramshorns should not be kept with large fish. Their eggs have transparent jelly capsules. The development of embryos may be followed with hand lens or microscope. A detailed, step-by-step study is an excellent project. The stages should be recorded by drawing and appropriate explanation. If the development proceeds too rapidly, low temperatures may be used to retard it.

5. Preservation

Snails may be killed by heating in water, or by dropping directly into a dilute solution of formalin. These two methods are convenient, simple and useful. Specimens thus treated may be studied at leisure. The water method may be used to clean shells for mounting. Various strengths of formalin may be used, and the effectiveness compared, 6%–10% being the preferred range of concentration.

6. Anatomy

The snail is classified as a representative of Phylum Mollusca, Class Gastropoda—that is, a mollusc with a head, a one-piece shell, and a body more or less spirally coiled.

Apparatus for studying effect of light on snails. A mercury arc source is mounted on an optical bench, with a holder for suitable filters and a ground-glass screen. The specimen is a large Japanese snail. The entire apparatus should be screened from external light. Photograph by A. E. Martin, Jr.

This coiling renders the dissection somewhat difficult. The large *Helix pomatis* is well suited for dissection.

The following parts should be identified: (a) head, with tentacles and eyes; (b) foot; (c) mantle cavity and mantle; (d) mouth, esophagus, stomach, salivary glands, buccal cavity, liver, intestine; (e) cerebral ganglia; (f) dart sac, vas deferens, penis sac, sperm duct, oviduct, vagina, testis, ovary; (g) heart.

7. External Effects

Interesting work may be done testing the influence of heat and effect of light on the behavior of snails. Regulated temperature "cells" with a wide range of temperature change may be used. Observations of the habits of the specimens may be recorded for set temperatures.

Terraria or aquaria may be illuminated by various types of light. With the many sources available today, an alert student may build up a profitable project. Comparison of the activity of the snails with respect to incident radiation may be made. This may be broadened for the advanced student by the insertion of various filters to allow the passage of limited wave lengths.

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Adaptation Via The Dandelion

ELMO N. STEVENSON
Southern Oregon College, Ashland, Oregon

"Each of you who finds a true dandelion near this spot will get a point. First you must go around this block. The one who gets around and finds the plant first will get two points. Ready, go," said the biology teacher. Soon the class had assembled around the best specimen discovered and were breathing heavily and ready to be quiet for awhile.

On the previous day the teacher had made this assignment. "Tomorrow we are going outside to study the adaptations of a common plant as an introduction to our next unit. What common weed do you want to know more about? Since the dandelion has been mentioned most often, we will study it. We will play a game to see who can get the greatest number of points—a point will be awarded for each fact presented. You have the remainder of this period and any other time you care to spend in gathering information on the dandelion."

TEACHER: "Mary, you start since you were here first."

MARY: "Now I can see why the dandelion gets its name. The edges of the leaves are deeply notched and sharp-pointed so that they resemble the teeth of a lion. The French called the plant *dents-de-lion,* and of course, we have just shortened this word to dandelion."

BOB: "No two leaves are alike."

DOROTHY: "The plant is like a big double rose. Is this arrangement the reason why they call the dandelion a rosette plant?"

TEACHER: "Yes, Dorothy. Can you see any advantages that the rosette arrangement has to the plant?"

JEAN: "Yes! Our arithmetic book shows that a circle has more area than any other form, so more leaf surface is exposed to the sunlight. And you'll notice the leaves rarely overlap one another though there are several tiers of them. The bottom ones reach out farthest and the succeeding tiers become shorter and shorter, until you come to the central bud. Those above do not prevent the sun from reaching the lower ones. The more sunlight a plant gets, the more food it can manufacture and the warmer it gets. Warmth is favorable for growth."

TED: "Jean's explanation makes it clear to me why the dandelion is one of the first plants to bloom in the spring."

JOHN: "The fact that this plant hugs the ground so, like a carpet on a floor, helps explain the reason why the dandelion is the last to bloom in the fall."

GORDON: "The plant lying flat on the surface of the ground would be in a position to absorb the last heat of the year and the first in the spring. Then, too, of course the moving air or the wind would only cool the top surfaces. Furthermore, the wind's speed would be very slow near the ground even though it may be blowing a gale at a higher point."

EVELYN: "The tap root of this dandelion which I just pulled up in the border of annuals is thick and fleshy. It looks like it might have a lot of stored food in it. Then, too, it goes down a long way and probably gets the first moisture and warmth in early spring."

TEACHER: "Your explanation is good, Evelyn. Did any of you find the scientific name of the dandelion?"

ALL: "Yes!"

LOIS: "I found it but I don't think I can pronounce it. It means nothing to me."

DORIS: "I found two scientific names and dozens of common names such as Blowball, Puff-ball, Irish Daisy, Yellow Gowan, Lion's Tooth and Lawn Dahlia. But which of its scientific names is preferable—*Taraxacum officinale* or *Taraxacum vulgare?* And what does the name mean?"

TEACHER: "We've seen both scientific names, but which is preferable, I don't know. *Taraxacum* comes from the Greek word 'Taraktikos,' which means a cathartic or laxative. *Officinale* and *vulgare* are Latin for 'medicinal' and 'common,' respectively. Both describe the plant's characteristics fairly well."

MAY: "Can you help me get this dandelion trombone to work? My dad used to put one dandelion stem into a larger one and then by blowing and by varying the length of the tubes he could play a simple tune, at least make a noise, and I can't even do that."

TEACHER: "Sorry, I can't. A dandelion trombone is a new one to me."

LOTTIE: "It is with me, too. But I can make dandelion curls. See! All you do is split the round flower stem into several strips and each one will curl."

DORIS: "Why, Lottie?"

LOTTIE: "I believe the explanation is that the soft inner tissue dries out rapidly, while the outer tissue does not and so the strips warp into curls because of the tissue strains. I know, also, that if you put the stem strips in water, they will also curve, but in the opposite direction and for the opposite reason."

PETER: "The dandelion flower and seed stem is hollow. This is a good principle in engineering. A hollow pipe doesn't collapse and still has strength. Just try and break that flower stem. Isn't it tough? The stresses and strains are equally distributed and so it makes for strength."

MARGARET: "I've been interested in tracing the life cycle of our friend here. Buds appear in the heart of the plant close to the ground such as this one. It takes about three days to open out and reveal the brilliant yellow flowers. Usually not more than half the flowers of the head open the first day. It may take several days for them all to blossom. During this time, bees and other insects are attracted to the pretty flowers and help carry out the pollination act. After the flowers have all bloomed, the head closes and the stem seems to lie over while the seeds mature. Then the stem straightens up and begins to lengthen out toward the sun and into the wind currents. The green bracts which enclosed the yellow flowers now re-open to disclose the seeds on their tiny hairy parachutes ready to sail away on a puff of wind. From bud to deposited seed takes about thirty days."

DEANNA: "After being told we were going to study the dandelion, I observed one in our garden and discovered that it went to sleep at night. That is, these green bracts enclose the flower at night as you would draw shutters up or down at night. It took about an hour for a dandelion head to open this morning. The flowers are out only five or six hours and then they close again for the night. The closing process takes about an hour."

ANN: "So this explains why a lawn looks like a golden carpet at noon with dandelion blossoms and like a green rug at night or in the late afternoon or early morning."

Group of teachers taking the dandelion field trip.

And so the class continued until a few minutes before the end of the period. During this time much data concerning the dandelion were contributed. The dandelion flower proved to be a head of similar florets which is a characteristic of one of the branches of the Compositae family of flowers. Other branches have ray and disk florets in the same flower head.

Some folklore items were encountered. Plucking the petals one by one until the last one reveals whether "he loves me

or he loves me not." The open blossom held under a person's chin indicates whether he or she likes butter. The number of seeds with tufted parachutes of feathery hairs after a long, hard puff indicates how much longer one is going to live, or how soon the blower will marry.

The dandelion seeds are covered with little barbs which enable them to cling fast wherever they chance to settle on the ground. The feathery parachute enables the seed to be carried by air currents. This umbrella-like structure is affected by the humidity so that the seed falls in favorable positions for growth. A dandelion plant produces two mature seed heads a week, each head bearing more than 125 seeds. Since the plant is a perennial, it has possibilities of producing 12,000 seeds a year. Enormous numbers of seeds make it possible for this plant to "people the earth." It is found in all lands from sea level to mountain tops. The dandelion is raised commercially in the state of Oregon and in New Jersey. These dandelion growers collect the heads of the plant and turn them into wine. They pluck the leaves and sell them for salads on the market. Several horticultural varieties have been developed that form large leafy plants. The roots are gathered and used for compounded medicines, such as laxatives, liver stimulants, etc. Besides the collecting of roots, leaves, and flower heads, the Oregon growers gather several thousand pounds of seeds annually to be shipped to the eastern markets for the manufacture of dyes.

The pollen grains are five-sided. As many as 250,000 such grains may be found in a single flower.

The leaves taste bitter. However, if the leaves are gathered when young and tender, thoroughly cleaned and then boiled, they make desirable greens. The cooking should not be too long so as not to lose the vitamin content. Those who do not relish the bitter taste had better change the water more than twice. These greens are generally served with a lump of butter and a dash of vinegar. Many prefer to cook them with a little fat, salt pork or bacon chopped fine, then serve with a sour cream dressing. Some prefer the leaves mixed with other greens. Dandelions are sometimes blanched and used raw as a salad. They are often cooked and served cold with or without vinegar.

The roots when dried may be used as a substitute for coffee and were used as such during the coffee rationing period in some sections of our country. The roots are also used in salads.

Dandelions are a source of latex, the stuff that rubber is made of. In Oregon they went so far as to introduce a Russian dandelion into the state as a potential source of rubber latex. However, the costs were so high and production so scanty that the "dandelion-for-rubber-project" was discontinued.

The dandelion is one of the chief competitors for space, food, and water in our gardens and lawns. As such, it is a pest and must be eradicated. The most common method of controlling the dandelion is to dig and pull it out, or cut it below the ground. The latter method will work only if one is persistent. If a part of the root is left, it forms a new plant. Digging is objectionable in lawns since the holes destroy the lawn's smoothness. Cutting is more effective if sodium chlorate, gasoline, acid or ammonium sulfate is sprinkled on the cut or broken root. Bulletins may be obtained from agricultural colleges and departments discussing the eradication of this weed. Aside from digging the holes, dandelions may be crowded out by establishing a thick turf.

Many other facts were brought out about the dandelion, including the recit-

ing of several poems and the citing of many magazine articles such as "Bearding the Lion in His Den" and "Gassing the Dandelions." Each item brought the contributor a point in the game.

A few minutes before the end of the hour, the teacher terminated the enthusiastic contribution and urged the students to play a round-up, continuous story game as a summary of what they had learned during the period. Each person was to take his turn in adding one fact about the dandelion. If any player in turn was unable to add an additional pertinent fact to the subject under discussion, and another could, that player had to pay a forfeit.

ANN: "The following are the tactics by which the dandelion has become so widespread and abundant: It blossoms and produces seeds from early spring to late fall."

MAY: "It flourishes on all sorts of soils and thrusts its long taproots down into the soil and thus gets moisture and food not reached by other plants."

LOTTIE: "Its leaves spread out from the base crowding and shading out all neighboring plants."

JOHN: "It has plenty of pollen carriers to insure strong seeds."

PETER: "It can develop seeds from its own pollen, or it can develop seeds without any pollen."

DOROTHY: "It develops almost numberless seeds, or akenes as the botanists call them, which are scattered far and wide by the wind."

JEAN: "It forms vigorous leaf rosettes in the fall and thus is able to begin growth early in the spring. It . . . ."

And so the story continued until everything which had been learned during the period had been told.

Several players found it necessary to sing a song together in order to redeem their forfeits, much to the delight of the class.

The field trip described above indicates the instructional potentialities inherent in objects in the immediate environs. Much was learned about the dandelion and it served well to introduce the unit on adaptation. Other common plants have just as interesting tales to reveal. Teaching techniques were presented that were interesting and effective. The field trip lesson was psychologically sound and ended with an overview-drill that knit the learnings into a whole.

Stock the Aquarium with Local Fishes

DONALD S. LACROIX
Amherst High School, Amherst, Massachusetts

In establishing aquaria for the school biology laboratory, why not use fishes that are found locally? "Punkin seeds" (a species of sun fish), bull-heads (horned pout), and pickerel are hardy varieties widely distributed around the United States. There are many others and all should be experimented with but inhabitants of fast-running brooks and rivers will not make successful additions to the aquarium. Also, some species will not get along well with others. Pickerel, for example, will devour anything their size or smaller; sunfishes are rather pugnacious, the larger ones tending to "bully" the smaller. We have kept pickerel in solitary confinement, and once brought two 4-inch specimens to-

gether in the same aquarium. After a few hours, the tail of one was sticking out of the mouth of the other. Bullheads mind their own business and spend most of their time feeding along the bottom. Small suckers are good scavengers.

An interesting addition to a large aquarium is the crayfish, but here a word of caution—segregate these fellows by placing a glass partition in the tank near one end, otherwise they'll make passes at the fish until the latter are so worn down that they become easy prey to the voracious crustaceans. And, too, crayfish have a taste for greens, and will chew up some kinds of water plants. Feed them a couple of earthworms a week just to keep them happy.

It is wise to stock the tanks with rather small specimens, fish up to 3 or 4 inches in length for large aquaria and 1 to $1\frac{1}{2}$ inches for smaller containers. If snails are to be included, they should be large ones so that the fish will not be tempted to nip them. One or two tadpoles should be included.

Water plants purchased from fish farms or biology supply houses will grow best in school aquaria.

You will find boys (and girls) who will be only too glad to collect fish for your school, and you will discover that the establishment of several small aquaria will serve as an incentive for the collecting activity.

Almost any clear glass container can be used. It is not necessary to buy an expensive tank, although one big aquarium is a valuable asset in any biology laboratory. Gallon jars, such as are used to supply mayonnaise to the hotel trade, make excellent tanks and have the advantage of being readily portable. Battery jars are used frequently. Tobacco jars can be pressed into service. Six or eight of these smaller aquaria scattered about the laboratory make interesting studies. Obviously only small fish (and a very few individuals) should be put in these. Large test tubes (1 in. $\times$ 10 in.) can be used for tiny aquaria where algae and small water plants can be observed with a hand lens.

From the aesthetic standpoint, the development of algae on the sides of an

aquarium is objectionable. Actually, these organisms indicate that the little watery world is operating normally and that conditions within it are at their optimum. Snails will take care of some of the algal growth, but if it becomes unsightly, it may be scraped off with a razor blade or a microscope slide. Water need never be changed unless the aquarium becomes fouled up with decaying organic matter. Under such conditions the whole thing might as well be thrown out and a new one started.

Low temperatures can obtain without hurting the wild forms of fish, but high temperatures are often fatal. A combination of high temperatures and prolonged exposure to direct sunlight will ruin aquaria.

AN EASY WAY TO LOCATE OBJECTS

Students often complain that they are unable to locate objects which are under observation with the microscope, such as certain cells, groups of tissues or mitotic figures. The instructor is then faced with the necessity of locating the object and of describing where it can be found so that the student can observe it. If the eyepiece of the microscope is equipped with a pointer this is relatively easy to do, but if not some other method must be used. In the writer's Biology classes there are lately many veterans of the Army and Navy who are familiar with a way of locating things in terms of the clock face. If such students wish to know, for example, where there is a cell at the metaphase stage in an *Allium* root-tip under observation on the microscope, all the instructor needs to do is to take a good look at the material and then to ask the student to search in the vicinity of "three o'clock," "six o'clock," or "eight o'clock," as the case may be. The student can then find the object with very little difficulty. Not only ex-service men, but also most other students seem to know of this system of describing locations as there have been frequent references to this in radio and cinema dramas. Doubtless there are other fields of instruction where it could be used to advantage, as on field trips or in explaining charts, diagrams or lantern slides.

FRED R. CLARK,
Ferris Institute,
Big Rapids, Michigan

A HIGH SCHOOL PROJECT ON INFANTILE PARALYSIS

MISS BETTY LOCKWOOD, of Redford High School, Detroit, Michigan, First Vice-President of THE NATIONAL ASSOCIATION OF BIOLOGY TEACHERS, has had an important part in a nation-wide program of Poliomyelitis Education sponsored by *The National Foundation for Infantile Paralysis, Inc.* She was selected to organize and present materials to several tenth grade classes. The entire project was under the supervision of S. D. Kramer, M.D., Epidemiologist of the Michigan State Department of Health. The results of the project have made possible the publication of a teacher's guide and a source book for use in a high school Unit on Poliomyelitis. These are available, free of charge, on request to *Education Service, The National Foundation of Infantile Paralysis, 120 Broadway, New York 5, New York.* Miss Lockwood's article in the October 1945 issue of *Science Education* includes a brief description of class procedures; reprints of this article are also available on request at the above address.

Miss Lockwood is well-known to many readers of THE AMERICAN BIOLOGY TEACHER for her work as guest editor of the *Ornithology Issue*, January 1944. We congratulate her upon her most recent opportunity to be of service.

The cuts that have appeared on the Calendar to date are by the courtesy of the *Slingerland-Comstock Co.*, Ithaca, N. Y. We regret that this information was omitted from the January and February issues.

Human Conservation

The war is over. What has come from it by way of improvement for our educational system? There have been several gains that are worth considering.

First, the stepped-up system of schooling employed by the army and navy showed that many young men and women could absorb their education in more potent quantities than those given in the high schools and colleges. This may be a clue to increase not only our content material, but its difficulty and application.

Secondly, newer methods of visual techniques, employed by the armed training centers, accelerated and simplified learning. The schools have always believed in visual aids but there are many areas lacking auditory and visual equipment. This is one place where school boards, Parent Teacher Associations and men's and women's clubs can assist the teacher working with limited tools. It is not necessary to own films, for 16mm and 35mm projections are available for loan from many sources.

Another realism of particular importance that has come home to us from the armed forces is the intensified health training program that needs to be incorporated into our schools. Certainly, the health program of the majority of our school systems over the country did not contribute to the war effort what had been normally expected. It was necessary to add considerable "war-time measure" to our high school curricula in order to satisfy the army standards and public sentiment. When the war ended, and even before, much of this new program was dropped. Is health any of the less important in peace than in war?

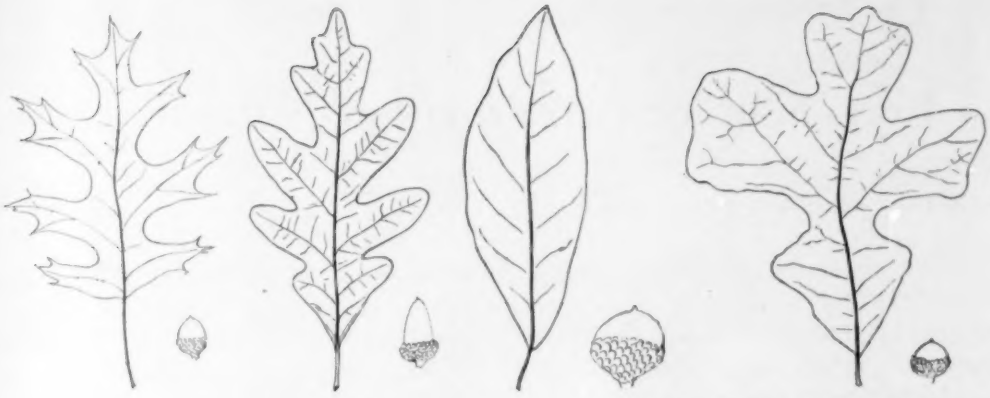
The Cardinal Principles of Education place the health of the child as the first responsibility of the school. This should mean the ingraining of habits of good health in such a way that not only are they practiced under the supervision of the school, but they are projected into the community and the home. However, when we examine most school curricula, we do not find much time or importance attached to training in better health habits for children. In the majority of school communities, the health program has been meagre. With occasional admonishments to "sit up straight, don't put your pencil in youth mouth, stop chewing your finger nails," the average teacher must be content. Isn't it time for the school to put as much emphasis on improving the health of the child as on improving his mind?

This may call for more training on the part of the average teacher than she now possesses, which may mean that our educational training institutions should have more to offer, perhaps that normal schools should require all prospective teachers to take a general course in health and health practices.

In many areas, nutrition education is being introduced as a part of the Health Education. The earlier in the school program these health practices can be introduced, the more they can be applied to a child's daily living pattern. The Nutrition Foundation, Inc., of New York City, an organization backed by some of the large food industries of the country, at the present time is financing an experimental study through the Harvard School of Public Health to determine the possibilities of nutrition education in the schools. The majority of State Boards of Health are most cooperative in furthering health education. The war intensified this; the schools should continue to take advantage of the opportunity.

The community may need to be made aware of this problem of the schools and be brought to realize that the solution belongs to the community in cooperation with the schools. In turn, the community is made up of homes. The ideal teaching situation is a combined Health Program for the school, the community and the home.

Betty Lockwood,
School of Public Health,
Harvard University



Courtesy Slingerland-Comstock Co.

APRIL 1946

1. Philip Munz, Cornell Botanist, born 1892		16. Frank B. Wann Utah Plant Physiologist, born 1892	
2. J. C. Blair, Illinois Horticulturalist, d. 1940		17. Clinton Abbott, Ornithologist, born 1881	
3. John Burroughs, Nature writer, born 1837		18. Herbert Wm. Conn, Biologist, died 1917	
4. H. P. Bowditch, Harvard Physiologist, born 1840		19. William Morton Wheeler, Entomologist, d. 1937	
5. Joseph Lister, English Physician, born 1827		20. Filbert Roth, Forester, born 1858	
6. Philip H. Gosse, English Naturalist, born 1810		21. John Muir, Naturalist, born 1838	
7. First National Bird Res. Estab. in Florida, 1903		22. Enos A. Mills, Nature writer, born 1870	
8. Arbor Day in Maryland, N.Y., N.J., Ore., and Va.		23. Augustus A. Gould, Conchologist, born 1805	
9. Leonard Barron, Garden editor, died 1938		24. Edward Howe Forbush, Ornithologist, b. 1858	
10. George Hill, Utah Plant Physiologist, born 1884		25. T. J. Burrill, Illinois Botanist, born 1839	
11. Luther Burbank, Plant breeder, died 1926		26. John James Audubon, Ornithologist, b. 1785	
12. Antoine de Jussieu, Botanist, born 1748		27. R. H. Wetmore, Harvard Botanist, born 1892	
13. Ray Lyman Wilbur, Stanford Physician, b. 1875		28. Ralph A. Waldron, Field Naturalist, b. 1888	
14. See Note Below		29. Edwin R. Kalmbach, Ornithologist, born 1864	
15. Arbor Day in Utah, Ind., and Colorado		30. Arbor Day in Mass.	

NOTE: For best suggestion for April 14 sent to E. L. Palmer, Ithaca, N. Y., in April a set of identification charts will be sent free. Send your suggestions for any date in remainder of year. Carver Day as suggested by Brother Christopher for January 5 wins the award for January.

A Live-Trap for Capturing Small Rodents

LLOYD C. HALL
Covina Union High School, Covina, California

Many times a biology teacher, regardless of the level at which he works, finds a need of having a ready supply of rodents. Perhaps the greatest immediate use is for feeding snakes. It has been found by the writer that many snakes reject young white rats or mice whereas house mice or native rodents are accepted.

This use, as important as it may be, is greatly overshadowed by a much more important and general value. Many teachers attempt to provide for the students, or stimulate the students to set up a collection of living animals of their community. This miniature zoo usually includes various invertebrates, fish, amphibians, reptiles, and a very obvious gap in the lack of native mammals. This omission is due in large part to the lack of facilities to capture them, which in turn has resulted in a lack of knowledge on the part of the teacher of the rodent life of his area.

A small collection maintained by the writer has exhibited tremendous value as a motivating device to make students conscious of the rodent world about them. The promotion of student activities in collecting and observation has been overwhelming. A collection of live white-footed mice, pocket mice, wood rats, meadow mice, and other available small rodents of fields and waste places not only incites this enthusiasm in the younger beginning students but should help initiate further investigations by the more advanced. Certainly one of the objectives of biology courses everywhere should be the familiarizing of our students with the living things close at hand. Further, there is the need by the specialist for a method of obtaining a supply of small rodents for research purposes.

With these points in mind the writer consulted the literature for tested traps that would enable a teacher to collect the smaller rodents with facility. Older papers on this subject usually referred to the figure-four trap or some adaptation of it. Miller and Blaydes (4) give a summary of this trap, with illustrations. This type is cumbersome to carry in the field and lacks sensitivity unless constantly repaired and adjusted. Sherman (5) describes a trap specially designed for capturing gophers. Moore (2) devised one made from a tin can and museum trap. The great disadvantage of this trap is the high conductivity of the thin metal which allows very low temperatures at night and high during the time sunlight might hit the trap. Later a special trap for moles was developed by Moore (3). This could be adapted for the obtaining of animals above ground but the expense and time of manufacture would prohibit its use to most workers. Chitty (1) developed a trap which incorporates many good ideas. It was made specifically for capturing voles. This trap requires considerable time in its production. Several features of this trap were utilized in the one described here.

An attempt was made to produce a trap that would have the following features: (1) high percentage of catch, (2) insulation against both high and low temperatures, (3) compact and easy to carry in the field, (4) low cost, (5) ease of manufacture in a small shop. The trap illustrated meets these points satis-

factorily. The writer has consistently obtained 90–100% catches in barns on overnight sets where house mice were very abundant. In the field overnight catches of 40–60% are regularly obtained where runs and other signs show that rodents are abundant. The top and bottom of one-inch surfaced white pine and the sides of one-quarter-inch weatherproof plywood adequately take care of the insulation. The trap is compact, light, and easily carried in the field. Twenty traps may be carried in a cardboard box or they may be tied with light rope into a compact bundle and carried over rough terrain with ease. The cost is low, approximately twenty cents each if new materials are used entirely. Lumber of this small size is usually present in large quantities in the school shop's scrap box. No tools other than common hand tools are necessary for its construction.

The nature of the trap may be determined by an examination of the figures. The rodent enters the front going to the rear to obtain the bait from the trigger of the regular house-mouse trap. When the trap is sprung, the wire which ordinarily snaps over the rodent pulls the wire attached to the door, thus closing the trap, and the spring action holds the door securely closed, yet the door holds the snap from swinging through its normal arc and pinning down the rodent. The same wire that pulls the door closed also holds the door open when the trap is set.

The details concerning the manufacture of the trap follow. Figure 2 shows the dimensions of the lumber. Parts *C* and *D*, the weatherproof plywood sides, and parts *A* and *B*, the top and bottom, are of the same dimensions and may be sawed out with the same setting of the power saw if one is used. Part *E*, the door, is also 4″ wide and may be sawed in the same operation. Nail the sides

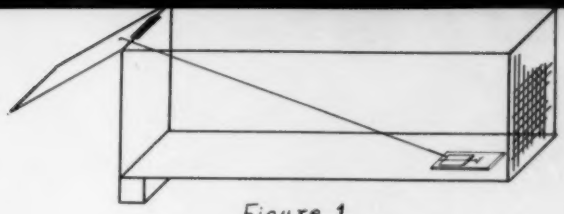


Figure 1

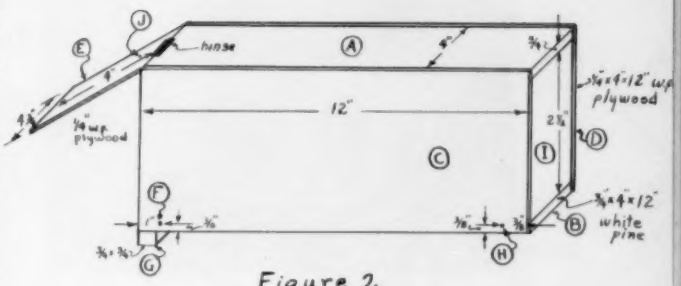


Figure 2

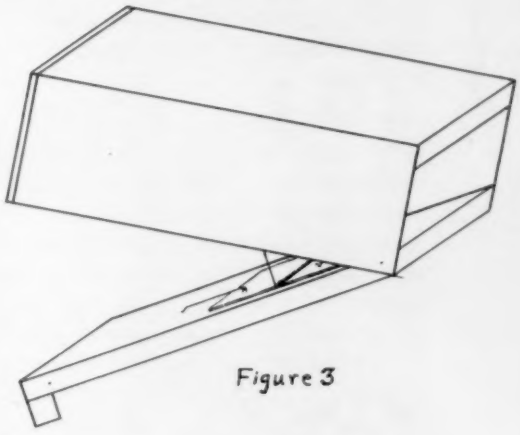


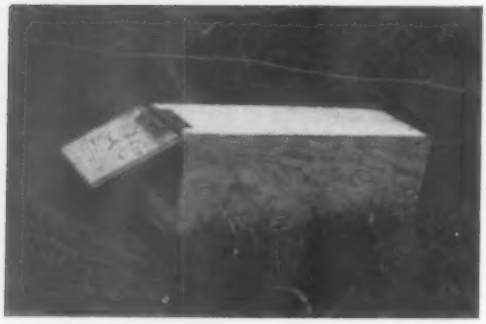
Figure 3

FIG. 1. Transparent view of trap with door in set position.

FIG. 2. Perspective view, in same position, showing dimensions.

FIG. 3. Trap with bottom lowered for baiting and setting.

(*C* and *D*) to the top (*A*) with 3d box nails. Nail the mousetrap to the bottom (*B*) in the position shown in Figure 1. The trap should be 1″ back from the end of the bottom (*B*). Nail the cleat (*G* in Figure 2) on to the bottom (*B*). This cleat should be 5″ long and extend ¼″ on each side. This cleat allows clearance from the ground when the door snaps shut. The holes at *H* may now be drilled, using a 3/32″ drill and passing only through the sides. 4d nails are driven through the holes into the bottom (*B*) and act as hinges. The holes at *F* are also 3/32″ and should be drilled approximately 1″ into the bottom (*B*). A 4d nail is pushed in here after the trap is set to avoid the opening of the trap by the spring action of the closure



Trap set in the field. Note that the cleat (*G* in Figure 2) raises the door end of the trap enough to clear grass so that the door may snap shut tightly.

or by its tipping over after the capture of the rodent. The hole is next drilled at *J* in the center and 1″ from the top of the door (*E*). The door is next hinged to the top (*A*) by a light cabinet hinge with dimensions of about $1\frac{1}{2}'' \times 2\frac{1}{2}''$. Use short stub screws or countersunk machine screws with the nuts on the outside. Fasten securely around the swinging snap portion of the mouse trap a piece of 20-gauge (0.032″) galvanized wire (see Figure 1) and place the other end through the door at *J*. Close the door and bottom and pull the wire through the hole until the snap is in a vertical position. Fold the wire down sharply, fasten with a small screen staple, and cut off excess wire. The $\frac{1}{4}''$ hardware cloth now should be stapled to the back end as shown in Figure 1. At the bottom at least $\frac{1}{2}''$ should be folded under the floor (*B*). No staples should be placed in the lower 1″ of the trap as this would prohibit the opening of the trap for baiting as shown in Figure 3.

To set the trap the nail is removed at *F* (Figure 2) allowing the trap to be opened as mentioned, the trigger baited, the bottom raised and locked again with the nail at *F*. The door should automatically be open but sometimes needs raising if the hinge is stiff or if the wire connecting the mouse trap to the door bends. The trap should then be placed in or close to a regular rodent run.

It is hoped that this work will stimulate the interest of biology teachers and their students in the interesting small rodent life that is around them. It is also hoped that improvements in the design of this trap or new traps with better features will be forthcoming from some of the readers.

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4. MILLER, DAVID F., AND GLENN W. BLAYDES. *Methods and Materials for Teaching Biological Sciences*. McGraw-Hill Book Co. 1938.
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FOR AN INTERESTING "BALANCED AQUARIUM" take a gallon-sized glass bottle of the type in which formaldehyde is shipped, put about an inch of washed sand and gravel in the bottom of it, plant one or two plants of "eel grass" and fill with pond water with a few snails, daphnia or other small crustacea, hydras, or any other small aquatic invertebrates. Do not place in direct sunlight for more than an hour or so a day; a north window is the best location for such an aquarium. If it must be placed in a south window, a piece of plaster board or cardboard may be set so as to furnish shade.

SAINT LOUIS MEETING

March 29–30, 1946

Room Assignments

DeSoto Hotel

Friday, March 29

Morning and afternoon sessions: *Parlor A* and *Parlor D*.

Evening session: *Parlor C*.

Saturday, March 30

Morning, afternoon and evening sessions: *Ballroom* and *Parlor C*.

The Preparation and Use of Kodachromes in Teaching Local Flora

BROTHER H. CHARLES, F.S.C.
St. Mary's College, Winona, Minnesota

How often have you felt a compelling urge to teach students to *know* the flora of your region? Have you responded to this inspiration? Or are you one of the many who are handicapped by lack of time or of access to places where plants can be studied in their natural habitats? Would you like to step over these barriers and bring into the lives of your students the glories of plants in bloom? If so, why not explore the possibilities of teaching them by means of Kodachrome slides?

Pictures stimulate interest and step beyond the limitations of our vocabulary in helping the mind to grasp a subject. The more lifelike the picture the better it puts across its idea. Consequently, pictures in natural color serve best. Animals, because their actions are usually more interesting than their form and markings, are best presented by the "motion" pictures. But in teaching about plants the use of "still" pictures has distinct advantages. In teaching local flora I prefer colored slides which show the plant and a little of its surrounding habitat.

Colored slides are either hand-tinted or made by the use of special color-sensitive film. The brilliant results obtained by color film have almost eliminated the larger, hand-tinted slides. Color film is easily procured, can be used satisfactorily in medium-priced cameras, is processed by the manufacturer, and is accurate in color detail. A considerable selection of color film "transparencies" are now available at the biological supply houses, and may be purchased at reasonable prices. Or the teacher can easily, and with little equipment and expense, make his own set of slides on the plants of the region. Slides made in the locality by the teacher usually have increased appeal for the students.

Equipment for making 2×2 transparencies should include a 35-mm. camera, a supplementary lens for close-ups, a lens hood, a haze filter, a tripod and a light meter.

The camera need not be an expensive one equipped with a fast, highly corrected lens. Stopping motion is not a problem when photographing plants. Lenses of medium- and low-priced cameras of the miniature type are corrected enough for ordinary color photography. A coupled range finder is very convenient for sharp focusing, but it is not essential. In fact, since it is advisable to use the maximum amount of film surface for the plant being photographed, supplementary lenses are usually necessary and the focus is set after the distance from the object to the lens has been measured. Most of my pictures are taken at a distance of from 16 to 18 inches, and I measure the distance for each exposure. I use a lens hood at all times.

Correct exposure is absolutely essential for accurate, brilliant color pictures. Sheets issued with Kodachrome film give exposure data for certain typical situations, but the conditions under which a nature photographer must work are so diverse that a more accurate gauge of exposure time and

lens aperture is necessary. A meter of the photoelectric type, such as the Weston, should be used in establishing your exposure schedule. An exposure record must be kept until you are thoroughly familiar with the performance of both your camera and meter in the various situations under which you take your Kodachromes. I find that the lens opening and exposure time indicated by my meter when held in the camera position give fine results for pictures taken at a distance of from 16 inches to 4 feet. For plants at a greater distance I take meter readings in the various parts of the field of the camera and calculate my exposure at a point midway between the greatest and least light intensity. As long as the difference in light in one part does not exceed that in others by eight times I can usually get a satisfactory over-all color record. In most cases I decide what part must be correct in color and, disregarding the other parts of the picture, expose for that part only. More brilliant Kodachromes result when the exposure is slightly under that indicated by the meter.

A stable tripod has distinct advantages. Kodachrome film is slow, and an aperture of about f.8 is recommended to insure sufficient depth of focus to show all the parts of the plant clearly. Consequently any movement of the camera will produce a fuzzy image which becomes more apparent when the transparency is enlarged in the projector. Using the tripod enables the photographer to obtain easily the desired framing of the plant.

The choice of photographic equipment is often a personal matter. Once you know the characteristics of your camera and meter and the allowances which you must make when using Kodachrome film, you should average 16 satisfactory results from each 18-exposure roll. But good results depend more on the ideas and technique of the operator than on the equipment, regardless of its excellence.

Kodachrome film is made to be used in direct sunlight without the use of filters, and uniformity of illumination insures an accurate color record. The colors of pictures when the subject is partly shaded, or when sharp shadows are produced by light striking at an acute angle, will vary from faded, thin colors in the better lighted areas to dark reds and blues in the shadows. To eliminate sharp shadows some photographers shade their subjects from the direct rays of the sun with a tent made of a single thickness of white cheesecloth. Many of my best pictures were taken when a tiny white cloud shielded the sun. On cloudy days I use a haze filter in my lens hood to prevent excessive blueness. I use it too whenever I take pictures of objects more than fifty feet distant.

Plants should be photographed where they grow. There and there only can we get the pictures which look natural. Though we are not conscious of it, reflections from surroundings notably alter the colors of plants. A distinctly white flower blooming alone in a mass of green has a greenish tinge which will be quite evident in your picture. The brown of fallen leaves gives a soft brown tone to spring blossoms. A color picture taken in the field records these reflections, is more natural to the eye, and is more suitable for teaching purposes than one taken after the plant has been removed from its natural habitat and photographed against some neutral background. The inclusion of the natural surroundings makes the picture more informative since it shows the type of habitat in which such a plant can be found.

Knowing *why* you want the picture is

probably the greatest factor in getting a satisfactory result. Getting *what* you want is one of the important advantages of taking your own pictures. Before I take a picture I decide exactly what I want to show—details of flowers or fruits, floral or leaf arrangement, the plant as a whole, or the relation of the plant to its surroundings—and then compose the picture to bring out my idea adequately. Often two pictures, an overall and a closeup, are necessary to bring out the idea. These are taken, provided that the light, the position of the plant, and the environment are either correct or can be made so. It is a waste of time and of film to make pictures which are not exactly what you desire. A little search for more suitable specimens, or the delay of a day or more to allow further growth, are usually productive of desired results.

The *why* of the picture must attract attention. This can be brought about by centering the point of interest or by regulating the depth of focus so that the plant is sharply outlined against a background which is just clear enough to give a general idea of the habitat. Proper centering of the point of interest requires an accurate framing mechanism. The framing mechanisms of miniature cameras, other than the reflex types, are not accurate when supplementary lenses are used. Experience will have to direct you as to what corrections are to be made for your camera.

After the film has been exposed it is shipped to the Eastman Kodak Company for processing. The film is returned to you as a developed positive, either in the original strip, or cut and placed in *Ready Mounts* suitable for immediate projection.

Ready Mounts are furnished without extra cost. They are light, durable, allow for expansion and contraction of the film, and are easily handled in projectors. The principal objection to them is that the film is exposed to dust and fingerprints. Films are better cared for if they are mounted between glass plates. The glass plates are either two inches square and bound together by adhesive tape, or smaller and held together in a narrow cardboard rim by means of aluminum coated paper which also serves as the mask. I prefer the second type since less breakage results from the rough handling which is often given classroom materials.

Transparencies should be stored in light-tight containers to prevent fading of colors. Exposure to strong light for days at a time has a bleaching effect. Repeated use of my transparencies over a period of six years has caused no appreciable change in the brilliance of the colors. They are stored in light-tight drawers.

How may color slides be used effectively in teaching others to recognize the plants common in their locality? The mere showing of slides and telling the names of things depicted are not enough to fix the picture in the mind of the student. Each slide should be described by pointing out a few well-chosen characteristics of each plant. In fact, I think the teaching of flora, whether in the field or in the laboratory by means of pictures, is efficient just in proportion to the teacher's ability to point out a *few* characteristics which will enable the student to identify the plant. Mentioning a multiplicity of characteristics results in confusion. The characteristics to be mentioned are determined by the experience of the teacher or may be secured from manuals which show them in italics.

The number of pictures to be shown is almost as important as the method of presenting them. Some years ago I

heard a teacher give a talk in which she mentioned that her students learned to identify as many as 43 plants in one hour. During this hour they mastered the principal characteristics as well as the names, both common and scientific. We listeners rolled up a wave of protest but she held to her statements. With due respect to the marvelous intelligence of our students and their learning ability, I do not think 40 is really a day's work. Rather it is more like a week's work. I feel that if a student learns 15 plants in an hour, he has mastered a reasonable number. No more than 25 plants should be presented in any one lesson.

My procedure in teaching spring flora is to flash a picture of a plant on the screen and ask for its identification. If the student is able to give the common name, I verify it and ask the students to write the name in their notebooks. Then I point out one or more of its characteristics. These are written in the notebooks also. The teacher should point out the characteristics rather than elicit them from the students. Students frequently give characteristics which are really not diagnostic and tend to confuse the whole group. Mentioning characteristics tends to bring about closer observation and writing them down fixes them in the minds of the students. After all the pictures have been shown I change the order of the pictures and show them again. This time specific students are asked to give the names. They are allowed to refer to the lists which they have just prepared. After the correct name is given the characteristics are asked for. Finally, the order of slides is again changed and the students are asked to write the names of the plants in the order in which they are shown. After showing all the slides the number of correct answers is determined. This is done either by calling the names in order, or better, by showing the slides again and having the names of each called by some of the pupils. Then each student is asked his score. The scores may be entered in the grade records, or the lesson may be more effective if the students compete with one another rather than for a mark.

After showing the slides the students are encouraged to get out into the fields and see how many of the plants they can find. (Whenever it is possible I accompany groups of as many as 20 into the fields on Saturday, holidays, or after class hours.) A report of their success is expected the following week. In each lesson so conducted a few slides from a previous showing are included. This repetition is continued often enough for those interested to learn to recognize the plants in the field.

NEW ENGLAND BIOLOGICAL ASSOCIATION

The New England Biological Association held its first meeting of the year on October 20, 1945, at the Arnold Arboretum in Forest Hill, Massachusetts, as guests of the Boston Mycological Club. Dr. Rolf Fenger identified various specimens found on the ground. About forty members and friends were present.

On December 8, 1945, the New England Biological Association met with the Eastern Association of Physics Teachers and New England Association of Chemistry Teachers at Simmons College in Boston. At the morning session the guest speakers included Edgar Burr of the Polaroid Corporation of Cambridge, Massachusetts, who spoke on *Polarized Light in Physics, Chemistry and Biology;* Curtis Hilliard, Head of the Biology Department, Simmons College, Boston, who spoke on *New Goals in School Health Programs;* Edward Schwarz, Head of the Textile Division, Massachusetts Institute of Technology, Cambridge, Massachusetts, who spoke on *Textile Research Looks Ahead.* In the afternoon R. L. Carpenter, Professor of Zoology at Tufts College, Medford, Massachusetts, spoke on *Practical Techniques for Slide Manufacture for the Biology Teacher.*

NEW APPOINTMENT TO OFFICE OF EDUCATION

Watson B. Miller, Federal Security Administrator, announced today the appointment to the United States Office of Education staff of Philip G. Johnson, who will serve as specialist for the natural sciences, in the Instructional Problems Section of Secondary Education, United States Office of Education. Dr. Johnson was born in Loomis, Nebraska, in 1900, received his B.S. degree from the University of Nebraska in 1923, his M.A. degree from the same institution in 1931, and his Ph.D. from Cornell University in 1933. He began his teaching career in the Havelock, Nebr., high school in 1923. Two years later he became supervisor of science instruction, University of Nebr. High School, Lincoln, Nebr. In 1935 he became assistant professor and supervisor of teacher training in science at Cornell University, adding in 1935 new responsibility as director of teacher training in science in the Ithaca, N. Y., public schools. He is author of numerous science publications, including among others: *The Sciences Need the Social Studies, Socializing the General Sciences, A Critique for the Evaluation and Development of Science Courses of Study for the Pre-College Years.* He is president of THE NATIONAL SCIENCE TEACHERS ASSOCIATION, and member of THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, THE NATIONAL EDUCATION ASSOCIATION, THE ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING, and THE NEW YORK STATE SCIENCE TEACHERS ASSOCIATION.

THE SILVER ANNIVERSARY YEAR of the National Society for Crippled Children and Adults marks the thirteenth *annual sale of Easter Seals for crippled children* as a special occasion. The 1946 Easter Seal Sale will be conducted during the month before Easter, *March 21 to April 21.*

A YOUNG NAVAL OFFICER writes to the *Atlantic Monthly:* "Ignorance is to blame for this whole bloody mess. The only thing I can see to do is to go after it on the ground floor. Think I could qualify as a teacher in the . . . public schools?" This young man gives as good a diagnosis of the cause and cure of World War II as is likely to be written.—"The Public and Education," Vol. 1, No. 3, January 7, 1946.

Books

SUMNER, FRANCIS B. *The Life History of an American Naturalist.* The Jaques Cattell Press, Lancaster, Pennsylvania. vii + 298 pp. 1945. $3.00.

It does not seem possible that the experience one goes through while reading this autobiography originates from the pages of a book; rather, one feels he has had a very long and enjoyable, yet definitely organized "bull session" with the author. His spontaneity, frankness, and logic arouse the reader's interest and inquisitive attention. The author really places himself open for criticism, sympathy and praise; being equally honest in relating his "peculiarities," personal adjustments and his accomplishments. Any young biologist would receive a personal boost from the turn of events in this man's life and realize the great and small have their ups and downs. It relates the experiences of early life interests of this man, and continues through his realistic and almost tragic trip to the Sudan, his work as a teacher and in the marine laboratories, and final years of outstanding (the author modifies that in characteristic modesty) work on natural selection, chiefly while residing in California. He displays sincere courage in his frank references on the sociological relationships of his field: such as family environment, personal contacts, the "Vivisection Bogey," local "Boosters" and Religion—giving the reader a final feeling of personal understanding and respect for the man and his real convictions, although not necessarily full agreement. His style of writing carries the content of the book quite effectively so that the reader lives in the excitement of thought stimulation, free criticism, but above all, contemplation and reflection on his philosophy.

LT. THEODORE DOWNS,
Medical Administration,
Army Air Forces

VERDOORN, FRANS. *Plants and Plant Science in Latin America.* Waltham, Mass., The Chronica Botanica Co.; New York City, G. E. Stechert and Co. xxxvii + 349. Illus. 1945. $6.00.

This collection of articles edited by Frans Verdoorn contain an account concerning the vegetation of natural resources, as well as the present status and future of a number of branches of plant science in Latin America. The first group of pages contain the editor's introductory essay, an excellent list of travel books of botanical interest and miscellaneous supplementary references. Part I consists primarily of articles not previously

published presenting problems, historical sketches and regional descriptions. Part II has reprints of important articles previously published in the columns of *Chronica Botanica*. Supplementary to the detailed table of contents is an index of personal names, and a list of the 34 plates and 48 illustrations (map forms) found throughout the text. This volume of information is written in an interesting style containing the technical names of the plants, several articles and explanations in the Spanish language, giving sources of information and subtitles in the guide topics at the top of each page with many footnotes below. Consequently this book can serve as a source of information for the botanist when he starts his work on the wild and cultivated plants of Latin America.

LILLIAN SCHAFER,
Instituta Biblica,
Palmira, Valle,
Colombia, South America

JORDAN, EDWIN O., AND BURROWS, WILLIAM. *Textbook of Bacteriology.* 14th ed. W. B. Saunders Company, Philadelphia. xvii + 909 pp. 242 illus. 1945. $7.00.

In view of the constant research and the new discoveries in the field of bacteriology, it is necessary to revise textbooks frequently. The fourteenth edition of this text retains the same general form, though the sequence of chapters is slightly different and some of the chapters have been rearranged. Additional material has been added to many of them.

The three chapters, *Actinomycetes, Molds and Mold-like Fungi* and *Yeast and Yeast-like Fungi* have been incorporated into one chapter called *Medical Mycology.* A considerable quantity of material has been added concerning molds and yeast. Under the former there is much discussion of the dermatophytes.

The chapter *Medical Parasitology* was written by R. J. Porter, of the University of Michigan. It includes a discussion of the protozoa and metazoa which are animal parasites. The two chapters, *The Filterable Viruses* and *The Virus Diseases of Man* were written by F. B. Gordon, of the University of Chicago. Several new virus diseases are discussed and additional material is given on some which were included in the last edition.

Many new pictures, charts and several disease distribution maps are included throughout the book. This volume is excellent as a text and as a reference book.

JEAN SCOTT MACFARLANE,
University of Kansas,
Lawrence, Kansas

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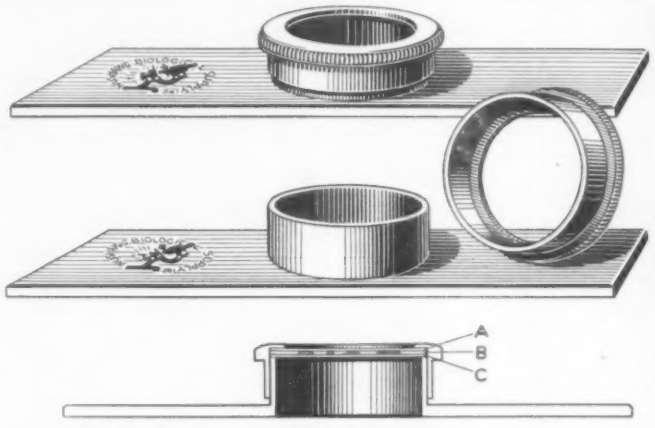

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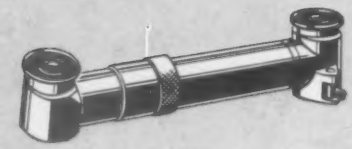

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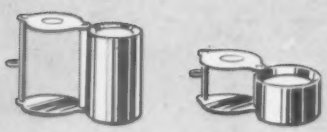

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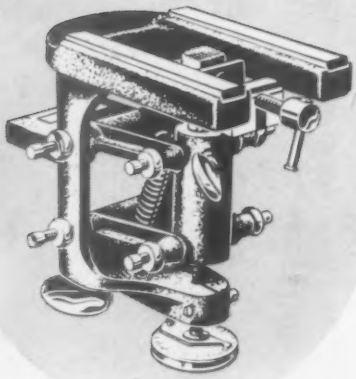

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